As Figure 7.33 indicates, a "good" schedule would assign the tasks T_1 (browning the meat), T_3 (simmering the meat sauce), T_5 (cooking the noodles), T_6 (beating the eggs), T_9 (assembling the layers), and T_{10} (baking the lasagna) to the first student. All other tasks would be assigned to the other student, who would actually be idle after the first 28 minutes.

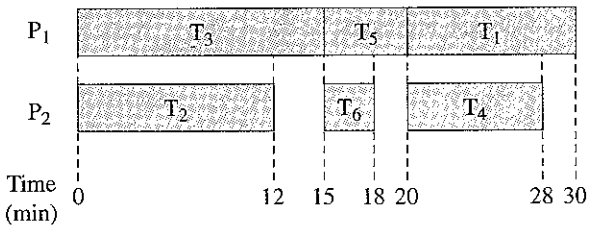
The finishing time for the lasagna project (with two processors and a decreasing-time priority list) is 90 minutes, or 7 minutes longer than the critical time of 83 minutes, as determined in Example 7.11 of Section 7.1. Compare this finishing time with the finishing time of 118 minutes in Example 7.9, when only one processor prepared the lasagna. Although the schedule of tasks described here is a "good" schedule, it may or may not be an optimal schedule for the lasagna project.

PROBLEM SET 7.2

1. Consider the project of getting ready for bed. The tasks involved and completion times are wash face (3 minutes), brush teeth (5 minutes), floss teeth (2 minutes), set alarm (1 minute), and change into pajamas (4 minutes).
   a. Construct the increasing-time priority list.
   b. Construct the decreasing-time priority list.

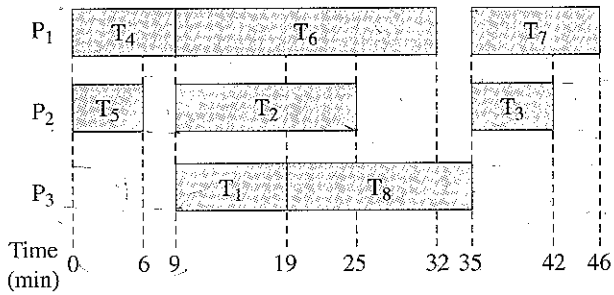
2. Suppose that a project consists of one person planting a tree. The tasks are T_1: dig a hole (30 minutes), T_2: insert tree (5 minutes), T_3: fill hole (10 minutes), T_4: fertilize (7 minutes), and T_5: water (15 minutes).
   a. Construct the increasing-time priority list.
   b. Construct the decreasing-time priority list.

3. Consider the following Gantt chart, where time is in minutes.



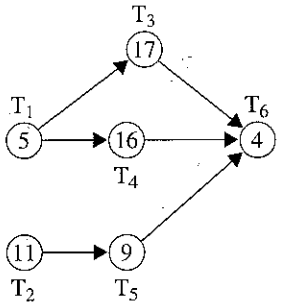
   a. How many processors are scheduled to work on this project?
   b. List the tasks and their completion times.
   c. What is the finishing time for this project?
   d. How much idle time is in this schedule?

4. Consider the following Gantt chart, where time is in minutes.



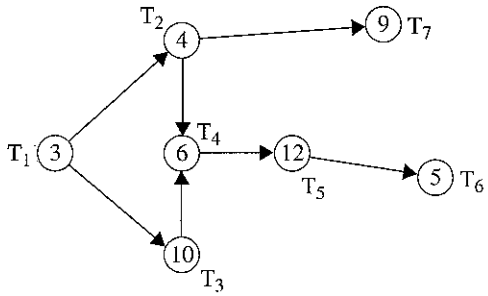
   a. How many processors are scheduled to work on this project?
   b. List the tasks and their completion times.
   c. What is the finishing time for this project?
   d. How much idle time is in this schedule?

5. Consider the following weighted order-requirement digraph for a project. Time is in minutes.



   a. Construct the increasing-time priority list.
   b. At the beginning of the project, which task(s) are ready?
   c. Construct the Gantt chart, assuming that there will be only one processor.

6. Consider the following weighted order-requirement digraph for a project. Time is in minutes.



a. Construct the increasing-time priority list.

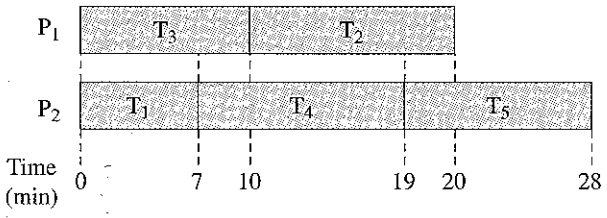
b. At the beginning of the project, which task(s) are ready?

c. Construct the Gantt chart, assuming that there will be only one processor.

7. Repeat problem 5 using a decreasing-time priority list.

8. Repeat problem 6 using a decreasing-time priority list.

9. Consider the following Gantt chart, where time is in minutes. As the project begins, task 1 and task 3 are the only ready tasks.

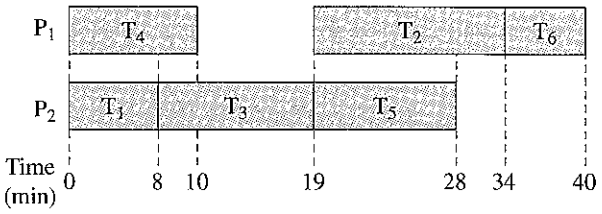


a. Explain whether the tasks as shown in the chart could have been assigned to the two processors using an increasing-time priority list.

b. Explain whether the tasks as shown in the chart could have been assigned to the two processors using a decreasing-time priority list.

c. Construct a possible weighted order-requirement digraph for the project.

10. Consider the following Gantt chart, where time is in minutes. As the project begins, task 1 and task 4 are the only ready tasks.



a. Explain whether the tasks as shown in the chart could have been assigned to the two processors using an increasing-time priority list.

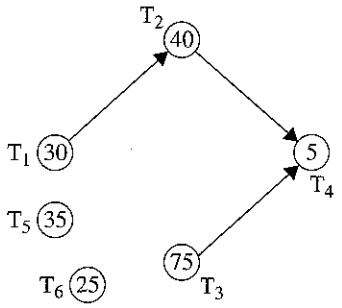
b. Explain whether the tasks as shown in the chart could have been assigned to the two processors using a decreasing-time priority list.

c. Construct a possible order-requirement digraph for the project.

11. Create one possible weighted-order-requirement digraph and a priority list, which would produce the Gantt chart in problem 3.

12. Create one possible weighted-order-requirement digraph and a priority list, which would produce the Gantt chart in problem 4.

13. Two people will make and serve a pot of coffee. The tasks involved in this project are T_1: insert a filter (30 seconds), T_2: add coffee (40 seconds), T_3: add water (75 seconds), T_4: turn on machine (5 seconds), T_5: set out cups and spoons (35 seconds), and T_6: set out cream and sugar (25 seconds). Consider the following weighted order-requirement digraph for the project.



a. Construct the increasing-time priority list.

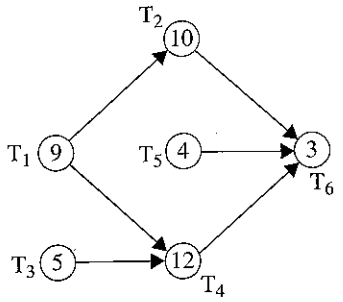
b. At the beginning of the project, which task(s) are ready?

c. How should the processors be assigned their first tasks according to the list-processing algorithm and the increasing-time priority list?

d. At what time is a processor idle, which task(s) are ready, and which will be assigned next?

e. Construct the Gantt chart and determine the time it takes to finish this project.

14. Two people will make breakfast, and their tasks are T_1: heat the griddle (9 minutes), T_2: fry bacon (10 minutes), T_3: mix pancake batter (5 minutes), T_4: cook pancakes (12 minutes), T_5: set table (4 minutes), and T_6: serve food (3 minutes). Consider the following weighted order-requirement digraph.



a. Construct the increasing-time priority list.

b. At the beginning of the project, which task(s) are ready?

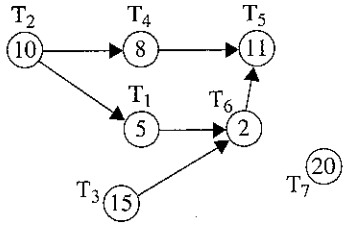
c. How should the processors be assigned their first tasks according to the list-processing algorithm and the increasing-time priority list?

d. At what time is a processor idle, which task(s) are ready, and which will be assigned next?

e. Construct the Gantt chart and determine the time it takes to finish this project.

Problems 15 and 16

Consider the following order-requirement digraph. Two processors will complete this project. All times are in minutes.



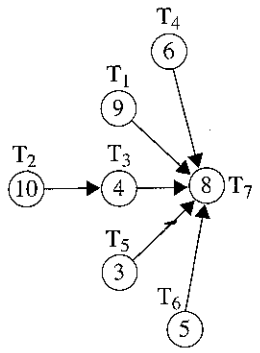
15. a. Schedule the tasks and construct the Gantt chart according to the priority list T_7, T_6, T_3, T_1, T_5, T_4, T_2.

b. What is the finishing time for the schedule in part (a) and what is the amount of idle time in the schedule?

16. a. Schedule the tasks and construct the Gantt chart according to the priority list T_2, T_1, T_6, T_5, T_3, T_4, T_7.

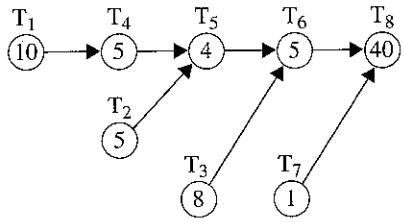
b. What is the finishing time for the schedule in part (a) and what is the amount of idle time in the schedule?

17. Consider the project of making lunches to take to school. The following weighted order-requirement digraph represents the project. The tasks are T_1: clean out lunch boxes (9 minutes), T_2: make sandwiches (10 minutes), T_3: wrap sandwiches (4 minutes), T_4: fill thermoses (6 minutes), T_5: wash apples (3 minutes), T_6: wrap cookies (5 minutes), and T_7: fill lunch boxes (8 minutes).



What is the critical time for this project, and how long would it take one processor to finish the project?

18. Consider the project of making a pizza. The following weighted order-requirement digraph represents the project. The tasks are T_1: roll out the dough (10 minutes), T_2: grate cheese (5 minutes), T_3: slice pepperoni (8 minutes), T_4: add sauce (5 minutes), T_5: add cheese (4 minutes), T_6: add pepperoni (5 minutes), T_7: turn on the oven (1 minute), and T_8: bake (40 minutes).



What is the critical time for this project, and how long would it take one processor to finish the project?

19. Refer to the digraph in problem 17.

a. Construct the increasing-time priority list.

b. If there are two processors, which tasks should be assigned to each processor first according to the list-processing algorithm and the increasing-time priority list?

c. Construct the Gantt chart. How long will it take two processors to complete this project?

20. Refer to the digraph in problem 18.
- **a.** Construct the increasing-time priority list.
- **b.** If there are two processors, which tasks should be assigned to each processor first according to the list-processing algorithm and the increasing-time priority list?
- **c.** Construct the Gantt chart. How long will it take two processors to complete this project?

21. Refer to the digraph in problem 17.
- **a.** Construct the decreasing-time priority list.
- **b.** If there are two processors, which tasks should be assigned to each processor first according to the list-processing algorithm and the decreasing-time priority list?
- **c.** Construct the Gantt chart. How long will it take two processors to complete this project?

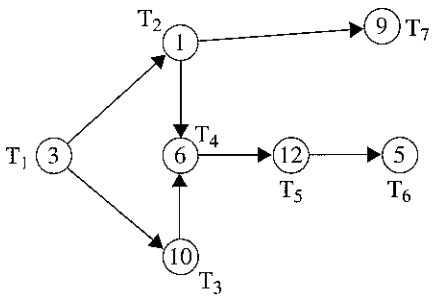
22. Refer to the digraph in problem 18.
- **a.** Construct the decreasing-time priority list.
- **b.** If there are two processors, which tasks should be assigned to each processor first according to the list-processing algorithm and the decreasing-time priority list?
- **c.** Construct the Gantt chart. How long will it take two processors to complete this project?

23. Refer to the digraph in problem 18. Construct the Gantt chart using an increasing-time priority list, assuming that there are three processors. How long will it take three processors to finish this project?

24. Refer to the digraph in problem 18. Construct the Gantt chart using a decreasing-time priority list assuming that there are three processors. How long will it take three processors to finish this project?

Problems 25 through 28

Consider the following weighted order-requirement digraph for a project. All times are in minutes.



25. **a.** Construct the Gantt chart, and determine the finishing time for the project if the increasing-time algorithm is used and there are two processors.
- **b.** Is the schedule optimal? Explain.

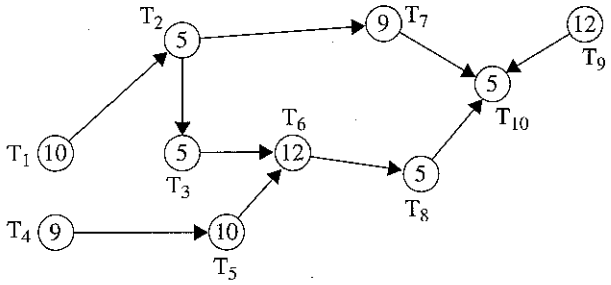
26. **a.** Construct the Gantt chart, and determine the finishing time for the project if the decreasing-time algorithm is used and there are two processors.
- **b.** Is the schedule optimal? Explain.

27. **a.** If three processors and the increasing-time algorithm are used, construct the Gantt chart and determine the finishing time for the project.
- **b.** Is the schedule optimal? Explain.

28. **a.** If three processors and the decreasing-time algorithm are used, construct the Gantt chart and determine the finishing time for the project.
- **b.** Is the schedule optimal? Explain.

Problems 29 through 32

Consider the following weighted order-requirement digraph for a project. All times are in minutes.



29. **a.** Construct the Gantt chart, and determine the finishing time for the project if the increasing-time algorithm is used and there are two processors.
- **b.** Is the schedule optimal? Explain.
- **c.** What is the total length of time that processors are idle?

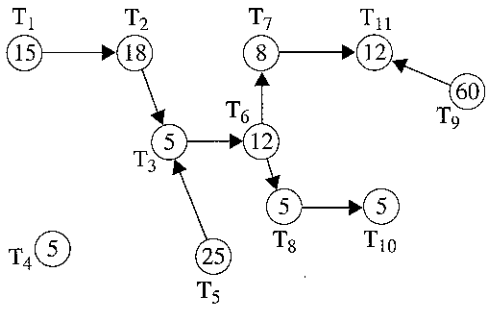
30. **a.** Construct the Gantt chart, and determine the finishing time for the project if the decreasing-time algorithm is used and there are two processors.
- **b.** Is the schedule optimal? Explain.
- **c.** What is the total length of time that processors are idle?

31. **a.** If three processors and the increasing-time algorithm are used, construct the Gantt chart and determine the finishing time for the project.
- **b.** Is the schedule optimal? Explain.
- **c.** What is the total length of time that processors are idle?

32. **a.** If three processors and the decreasing-time algorithm are used, construct the Gantt chart and determine the finishing time for the project.
- **b.** Is the schedule optimal? Explain.
- **c.** What is the total length of time that processors are idle?

Problems 33 through 36

Consider the following weighted order-requirement digraph for a project. All times are in minutes.



33. a. Construct the Gantt chart, and determine the finishing time for the project if the increasing-time algorithm is used and there are two processors.

b. Is the schedule optimal? Explain.

c. What is the total length of time that processors are idle?

34. a. Construct the Gantt chart, and determine the finishing time for the project if the decreasing-time algorithm is used and there are two processors.

b. Is the schedule optimal? Explain.

c. What is the total length of time that processors are idle?

35. a. If three processors and the increasing-time algorithm are used, construct the Gantt chart and determine the finishing time for the project.

b. Is the schedule optimal? Explain.

c. What is the total length of time that processors are idle?

36. a. If three processors and the decreasing-time algorithm are used, construct the Gantt chart and determine the finishing time for the project.

b. Is the schedule optimal? Explain.

c. What is the total length of time that processors are idle?

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37. Guests will be arriving and will expect dinner promptly at 6 P.M. The hosts must complete the following tasks in order to prepare dinner (the project).

a. Create the weighted order-requirement digraph for this project. Find the critical time and the finishing time for one processor.

b. Assign tasks, and create a Gantt chart using an increasing-time priority list and two processors. Is the schedule optimal? What time must the hosts (the processors) start the project in order to be finished by 6 P.M.?

c. Assign tasks, and create a Gantt chart using a decreasing-time priority list and two processors. Is the schedule optimal? What time must the hosts (the processors) start the project in order to be finished by 6 P.M.?

Task	Task Description	Completion Time (Minutes)	Prerequisite Task
T_1	Defrost chicken	15	
T_2	Remove skin from chicken	5	T_1
T_3	Coat chicken in flour/spice mixture	5	T_2
T_4	Brown chicken in frying pan	15	T_3
T_5	Bake chicken in oven	45	T_4
T_6	Peel potatoes	10	
T_7	Cube potatoes	5	T_6
T_8	Boil potatoes	30	T_7
T_9	Shuck corn	10	
T_{10}	Boil corn	10	T_9
T_{11}	Drain potatoes	2	T_8
T_{12}	Mash potatoes	5	T_{11}
T_{13}	Make gravy with frying pan drippings	10	T_4
T_{14}	Set table	10	
T_{15}	Serve food	5	$T_5, T_{12}, T_{10}, T_{13}, T_{14}$

38. Your child is turning 8 years old and you have invited 16 kids to her birthday party. You have work to do. The following tasks must be completed before the guests arrive.

a. Create the weighted order-requirement digraph for this project. Find the critical time and the finishing time if you are the only processor.

b. Schedule tasks, and create a Gantt chart using an increasing-time priority list for you and a helper (two processors). Is the schedule optimal?

c. Schedule tasks, and create a Gantt chart using a decreasing-time priority list for you and a helper (two processors). Is the schedule optimal?

Task	Task Description	Completion Time (Minutes)	Prerequisite Task
T_1	Make a list	20	
T_2	Buy gifts	180	T_1
T_3	Buy groceries	90	T_1
T_4	Buy decorations	45	T_1
T_5	Clean house	120	
T_6	Wrap gifts	30	T_2
T_7	Decorate house	60	T_5, T_4
T_8	Fill piñata	5	T_3, T_4
T_9	Hang piñata	10	T_8
T_{10}	Bake cake	45	T_3
T_{11}	Decorate cake	60	T_{10}
T_{12}	Set up game	20	
T_{13}	Greet guests	10	T_{12}, T_{11}, T_9, T_7, T_6

Extended Problems

39. Throughout this section, we have used a display called a Gantt chart. This type of display, which uses time as the basis for scheduling, was developed by Henry Gantt. Who was Henry Gantt? Read about him and the history behind the Gantt chart. Research information about his job and what motivated him to create the chart. When was the chart developed, and how is it commonly used today? For information on the Internet, use search keywords "Gantt chart history." Summarize your findings in a report.

40. In this section we introduced the list-processing algorithm. We considered the increasing-time algorithm and the decreasing-time algorithm. Many other algorithms used to create schedules exist. Scheduling is a very active branch of both mathematics and management science. Research current trends in scheduling algorithms and write a report that summarizes the basics of several algorithms not discussed in this section. Consider algorithms such as the decisive-path algorithm, the most-often-used-path algorithm, and the time-constrained algorithm. How are tasks prioritized in each of these algorithms?

41. Think about a complex project you have worked on recently. List all the tasks and their completion times. Create a weighted order-requirement digraph for the project. Calculate the finishing time and the critical time.

a. Use an increasing-time priority list, and assign the tasks to two processors. How long will it take to finish the project? Is the schedule optimal? Explain.

b. Use a decreasing-time priority list, and assign the tasks to two processors. How long will it take to finish the project? Is the schedule optimal? Explain.

c. Use an increasing-time priority list, and assign the tasks to three processors. How long will it take to finish the project? Is the schedule optimal? Explain.

d. Use a decreasing-time priority list, and assign the tasks to three processors. How long will it take to finish the project? Is the schedule optimal? Explain.